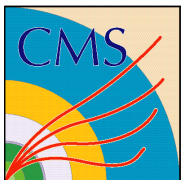




# **MET Performance Studies with Full Simulation**

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**7-June-2000**



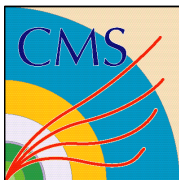
# Issues

## MET Resolution

- $\text{MET}(x,y) = -(\sum E_x(i), \sum E_y(i))$   
 $\sigma(\text{MET}) = a/(\sum E_t(i))^{1/2},$  (I: readout channel)
- Sensitive to
  - pile-up
  - noise / dead channels
  - threshold in readout
  - LSB (L1:  $\sim 1\text{ GeV}$ , offline  $0.2\text{ GeV}$ ) ?
- How to improve?

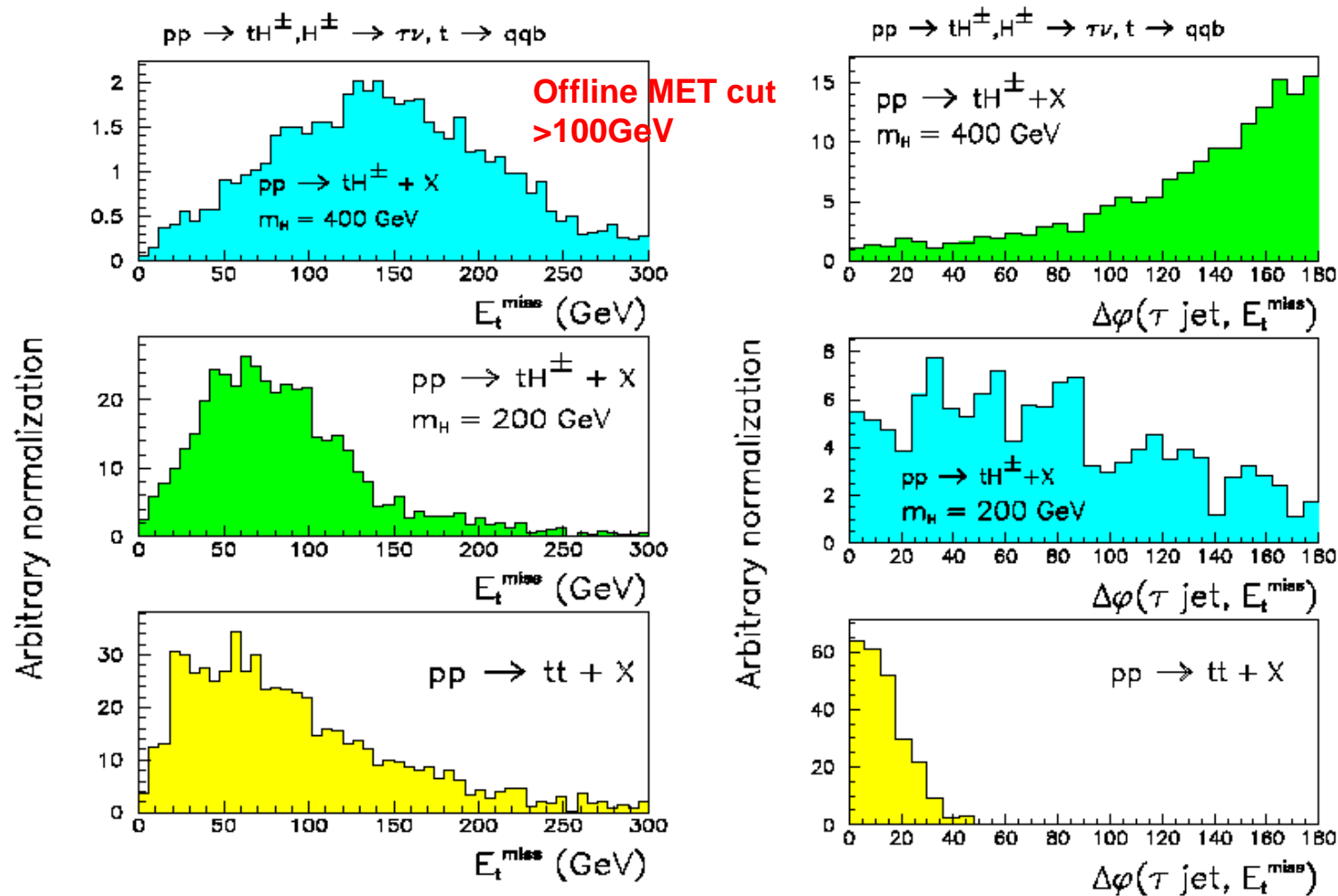
## Trigger

- How low threshold can we go?
  - Limited by resolution for QCD events with zero MET.

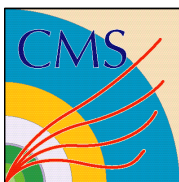


# MET in $tH^\pm$

Reconstruction with CMSJET



(R.Kinnunen)



# tH<sup>+</sup> : Selection & Signal

Event selection for tH<sup>+</sup>, H<sup>+</sup> -> τν, τ -> h<sup>+</sup> + X

Events for 10<sup>5</sup> pb<sup>-1</sup>

1) τ selection:

jet, E<sub>t</sub> > 100 GeV, |η| < 2.5 containing  
one track with  $r = p^h / E^{\text{jet}} > 0.8$ , ΔR(jet, track) < 0.1

m<sub>T</sub>(τ jet, E<sub>t</sub><sup>miss</sup>) > 100 GeV

Signal

Background  
tt, Wtb, W+jet

2) E<sub>t</sub><sup>miss</sup> > 100 GeV

m <sub>A</sub> = 400 GeV, tanβ = 30	68.5	25.6
m <sub>A</sub> = 200 GeV, tanβ = 20	41.1	25.6
m <sub>A</sub> = 600 GeV, tanβ = 40	33.5	25.6

3) W and top mass reconstruction from jets with E<sub>t</sub> > 20 GeV

minimizing  $\chi = (m_{jj} - m_W)^2 + (m_{jjj} - m_{\text{top}})^2$

m<sub>T</sub>(τ jet, E<sub>t</sub><sup>miss</sup>) > 200 GeV

4) W mass cut, |m<sub>jj</sub> - m<sub>W</sub>| < 15 GeV

m <sub>A</sub> = 400 GeV, tanβ = 30	61.9	7.8
m <sub>A</sub> = 200 GeV, tanβ = 20	12.5	7.8
m <sub>A</sub> = 600 GeV, tanβ = 40	31.8	7.8

5) top mass cut, |m<sub>jjj</sub> - m<sub>top</sub>| < 20 GeV

6) Tagging of the jet not assigned to W with E<sub>t</sub> > 30 GeV, |η| < 2.5,

efficiencies from TDR (2 tracks, p<sub>T</sub> > 1, GeV, σ<sup>ip</sup> > 2):

50% for b-jets, 1.3 % for non-b-jets

m<sub>T</sub>(τ jet, E<sub>t</sub><sup>miss</sup>) > 100 GeV, second top and jet veto

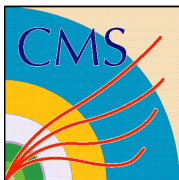
7) Central jet veto, E<sub>t</sub><sup>jet</sup> > 40 GeV

m <sub>A</sub> = 400 GeV, tanβ = 30	37.8	4.2
m <sub>A</sub> = 200 GeV, tanβ = 20	18.2	4.2
m <sub>A</sub> = 600 GeV, tanβ = 40	17.9	4.2

8) Second top veto, |m<sub>τνj</sub> - m<sub>top</sub>| > 130 GeV

9) transverse mass reconstruction m<sub>T</sub>(τ jet, E<sub>t</sub><sup>miss</sup>)

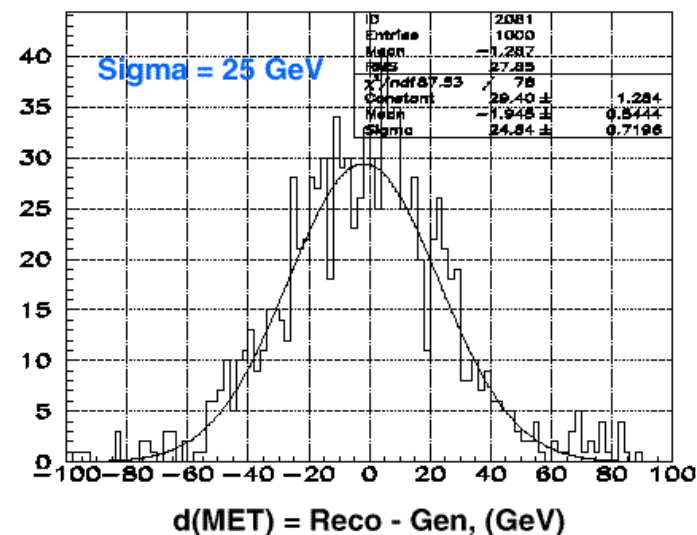
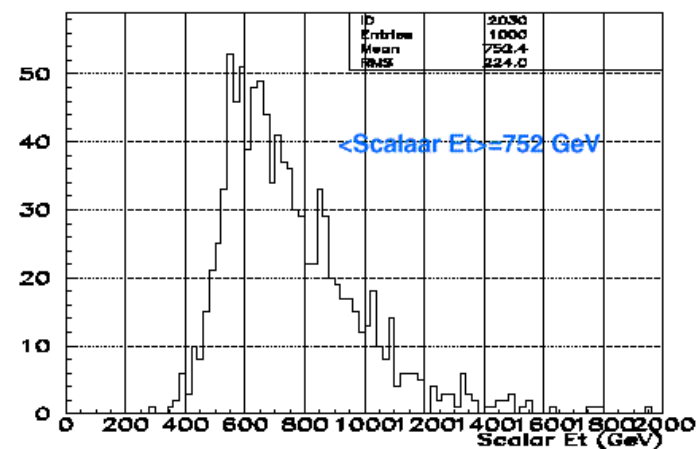
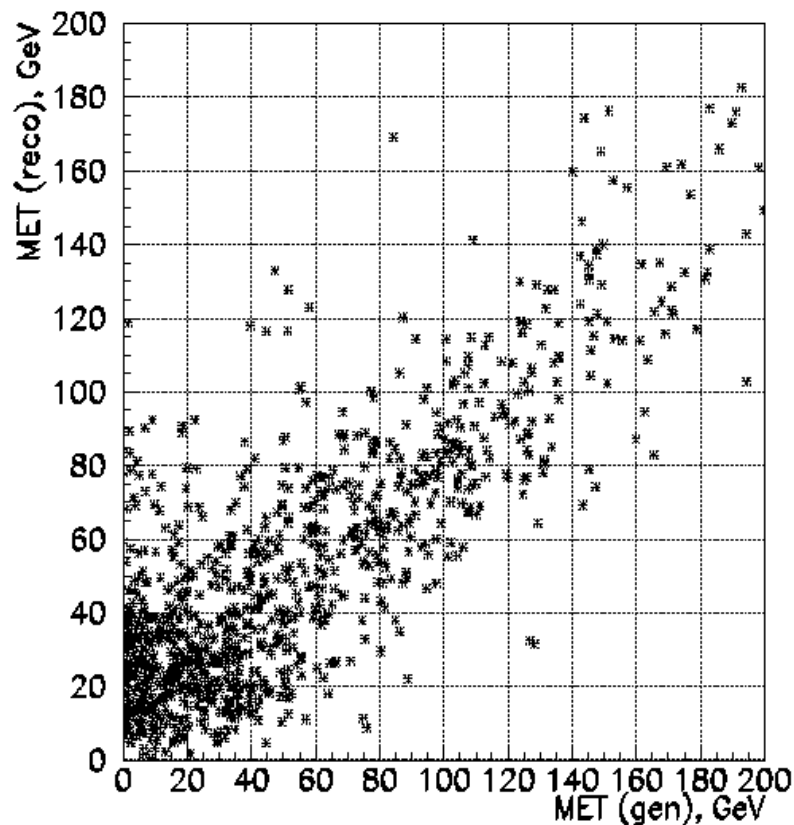
**Assumed Trigger: 3 jets (E<sub>t</sub> > 20 GeV) plus tau-jet (E<sub>t</sub> > 100 GeV)**

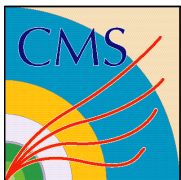


# Offline MET Response

**ttH(110)** no min-bias overlap

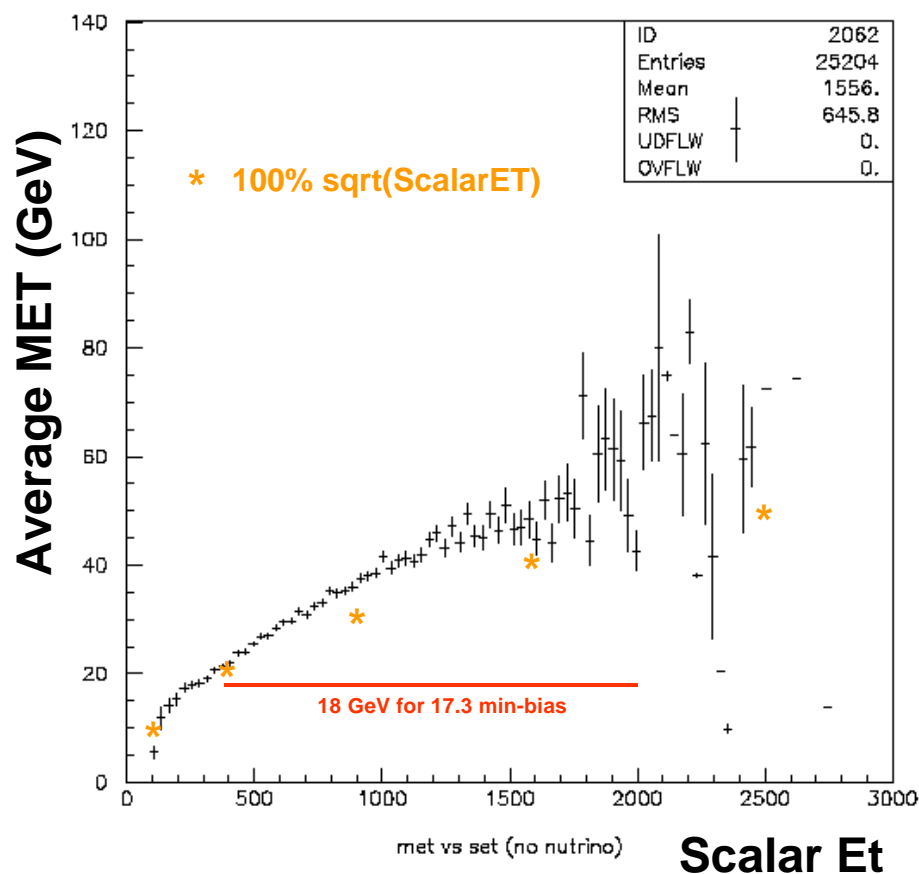
(H→bb)





# Offline MET Resolution

QCD Jets with no neutrino/muon  
(no pile-up)



$$E_x = \sum (E_{x\text{-tower}})$$

$$E_y = \sum (E_{y\text{-tower}})$$

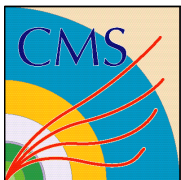
Any way to improve this?

e.g.

$$E_x' = E_x + \sum (\Delta(E_{x\text{-jet}}))$$

$$E_y' = E_y + \sum (\Delta(E_{y\text{-jet}}))$$

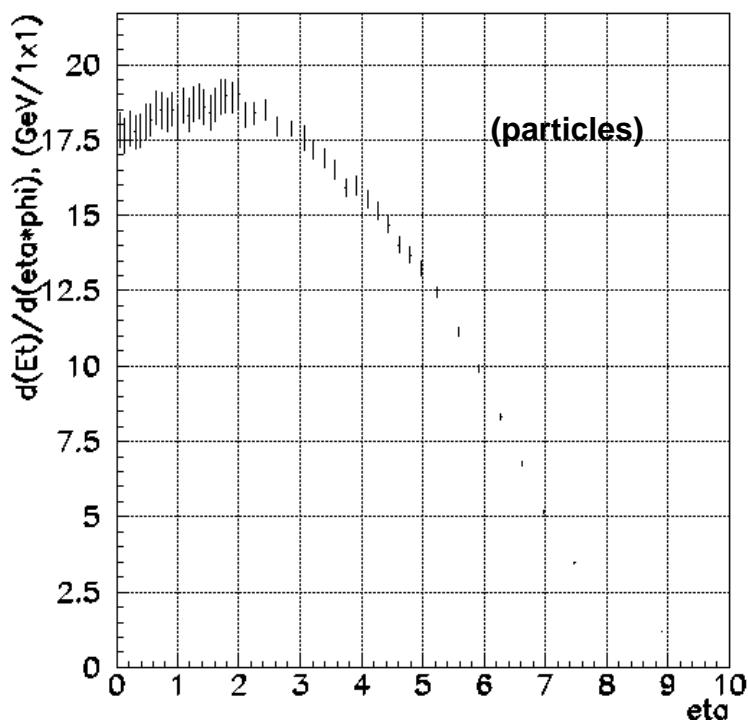
Does this work?



# Minimum Bias Event Overlap (in-time only)

**X-sec = 55mb >>> 17.3 min-bias/crossing at 10E34**

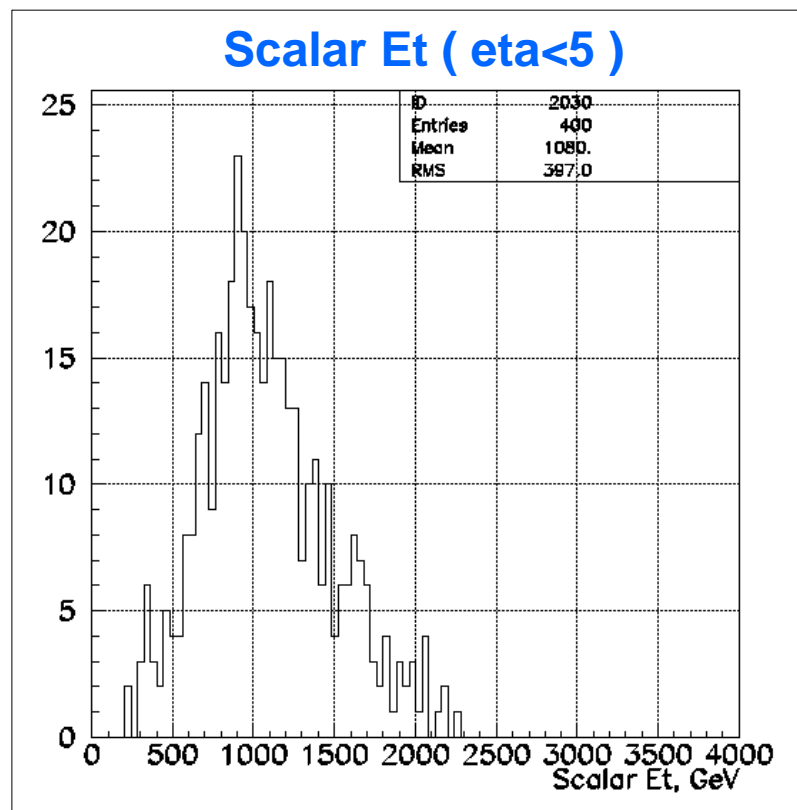
**Et Flow**



**~17 GeV in unit (eta x phi) !**

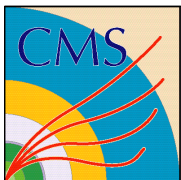
(equiv. cone radius 0.56)

**Scalar Et ( eta<5 )**



**<Scalar Et> = 1080 GeV**

Note: <Scalar Et> = 750 GeV for ttH

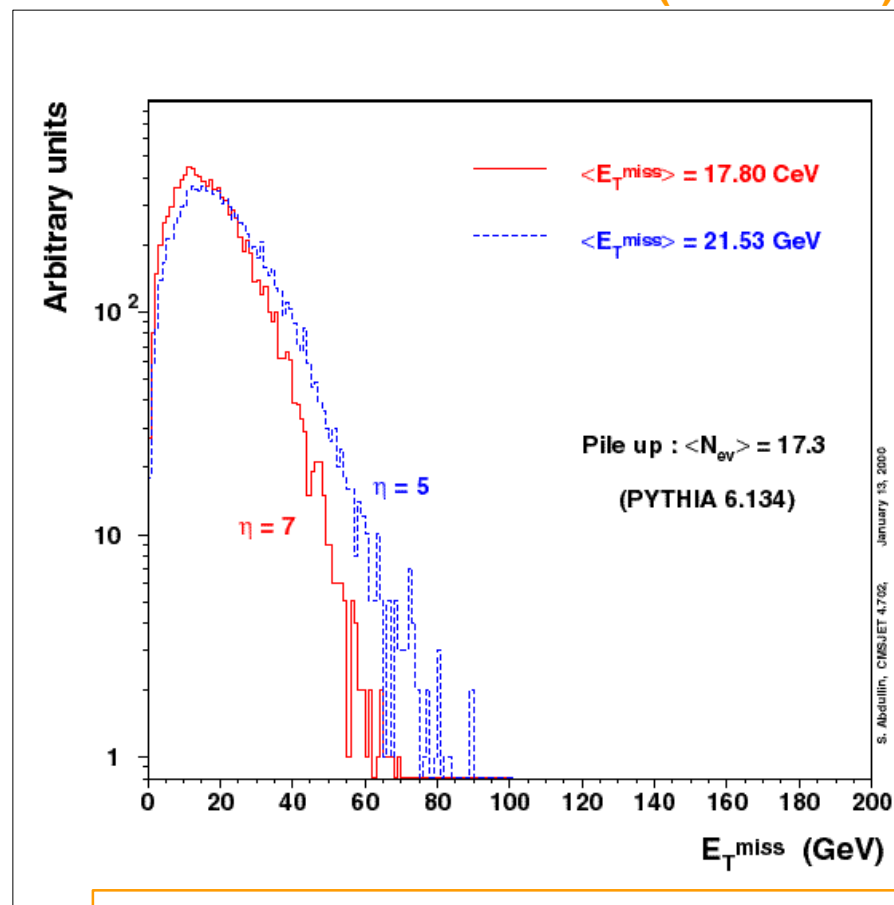
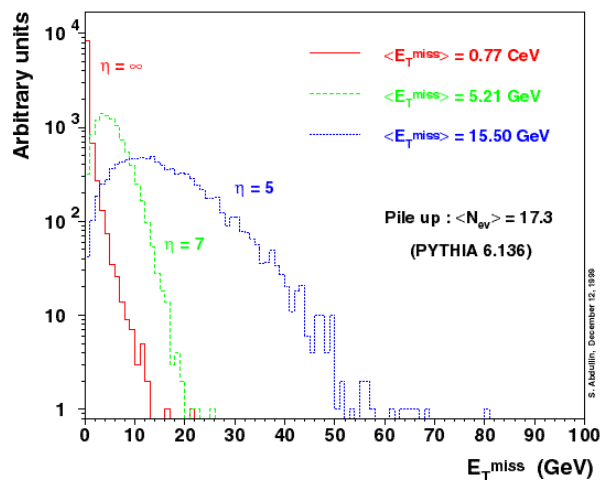


# MET with Pile-up (eta 5 vs 7)

(CMSJET simulation)

(S.Abdullin)

Particle level  $E_{T,miss}$  calculation for various  $\eta$  coverage



**MET (GeV)**

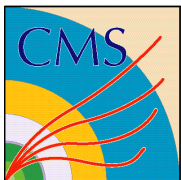
	gen.	cmsjet	
eta		res.	all(*)
5	15.49	19.36	21.53
7	5.21	12.92	17.80

(all = res. & B-field & vtx smearing)

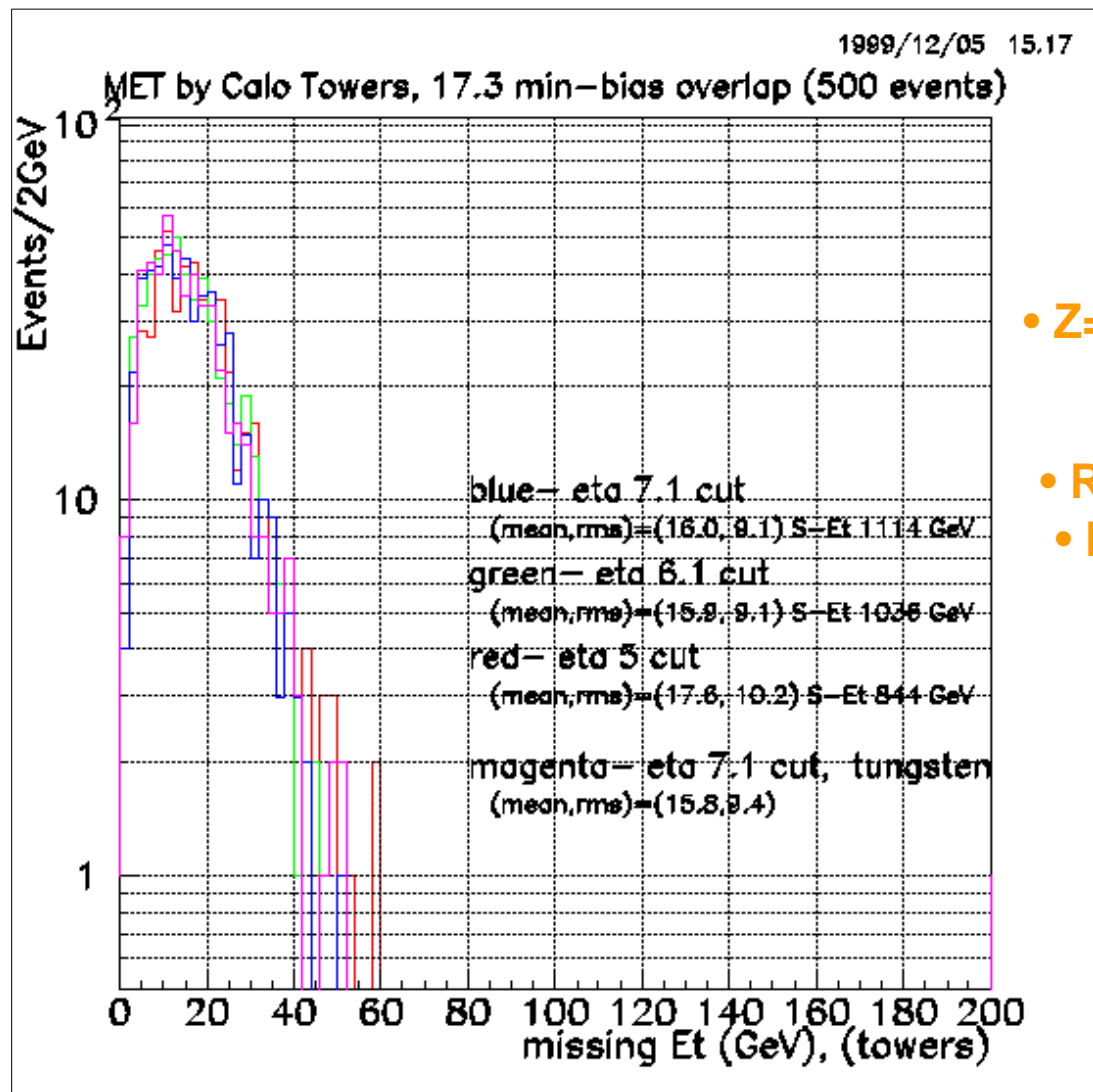


~ Equal contribution from  
eta 5-7, resolution and B-field  
(15GeV) (12GeV) (9-12GeV)



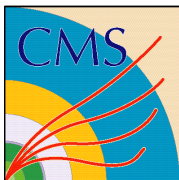


# CMSIM Simulation



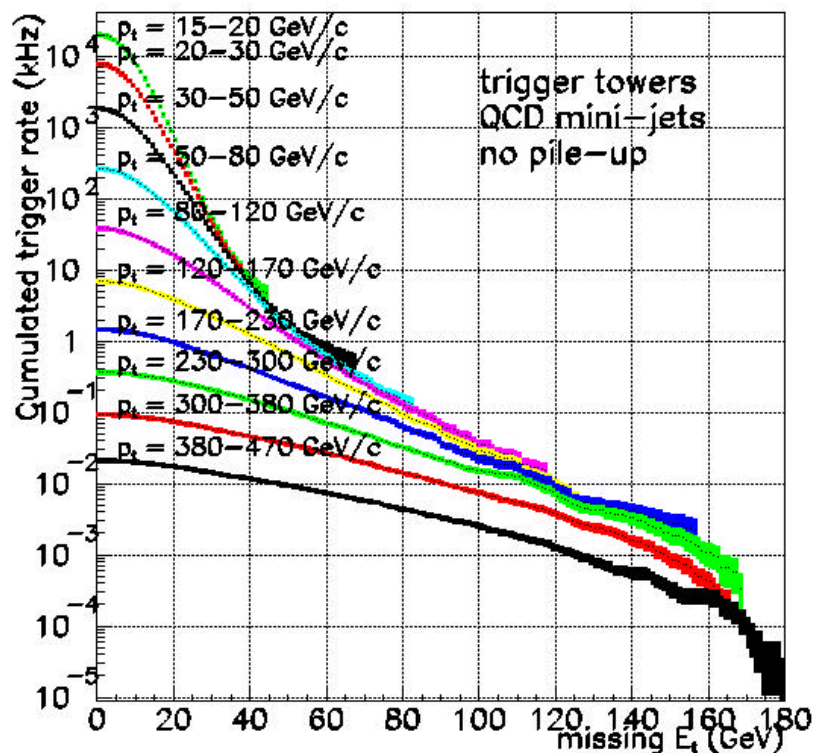
## HF2:

- Z=1613-1628-1748-1778cm  
em had tail
- Rin= 2.5cm, Rout=130cm
- Material: Cu(W) + fibers
- Segmentation  
eta=0.348, phi=20deg.
- Size  
6.1x7.2cm at eta 5  
:  
1.1x0.9cm at eta 7

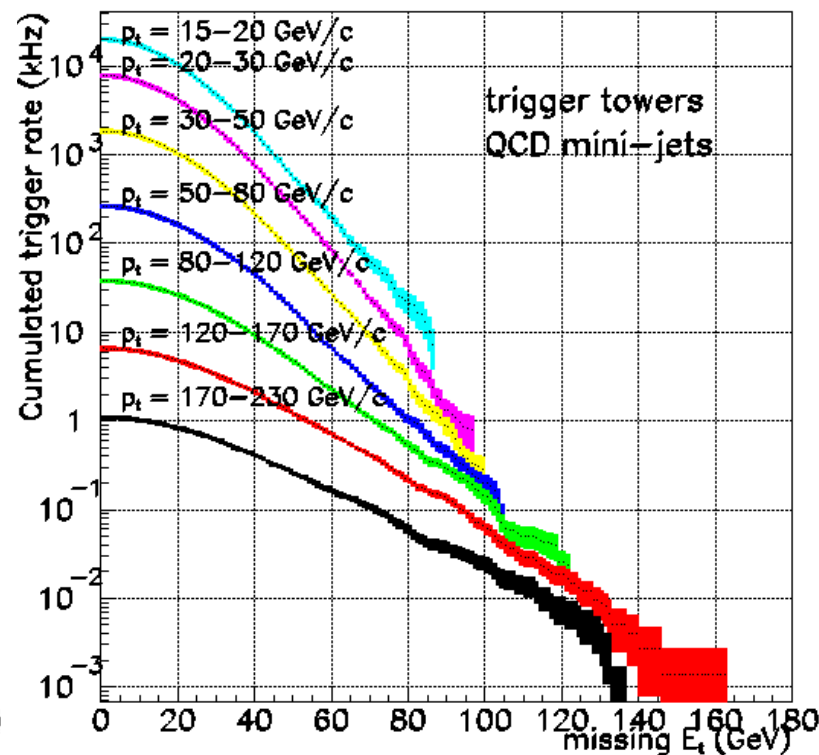


# Rates with Pile-up (ORCA3)

No pile-up

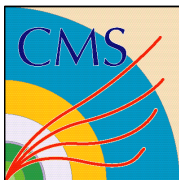


In-time pile-up

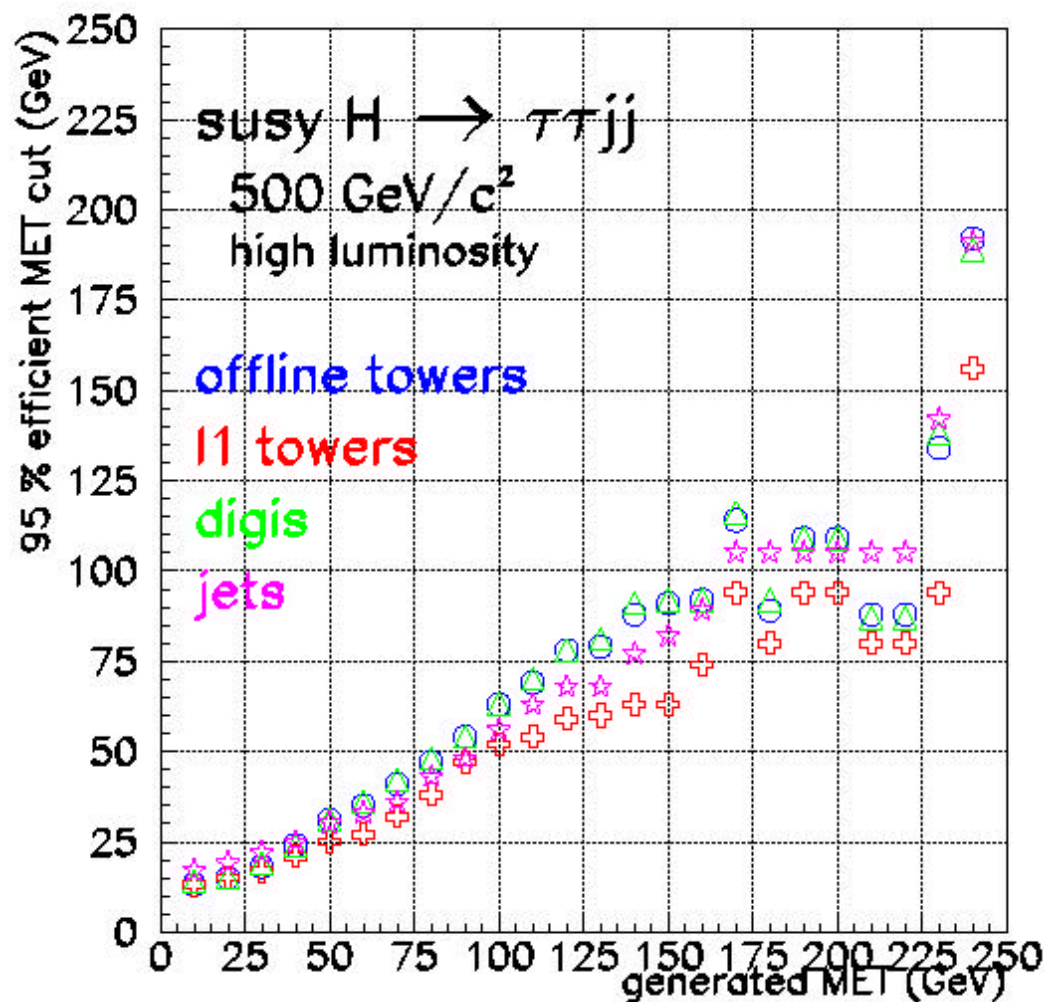


Huge rate below MET < 100 GeV  
due to min-bias at 10E34.

(P.Hidas)



# MET Threshold for 95% efficiency



Different ways to  
calculate MET

Note:  
H→tau+tau is  
relatively low  
jet multiplicity events.

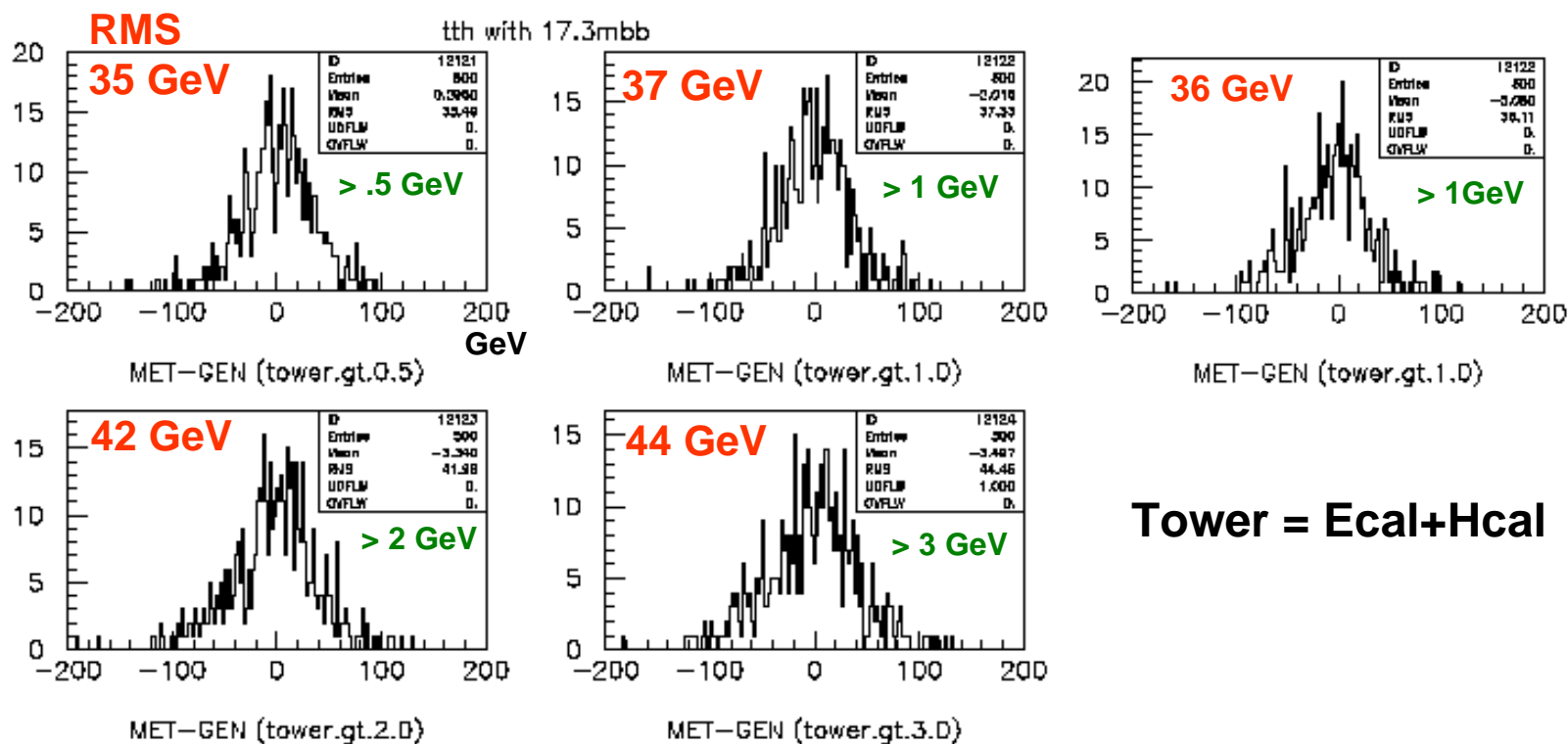
(P.Hidas)



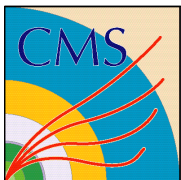
# MET for Signal Events with Pile-up and Tower Threshold

ttH(110) with 17.3 min-bias events

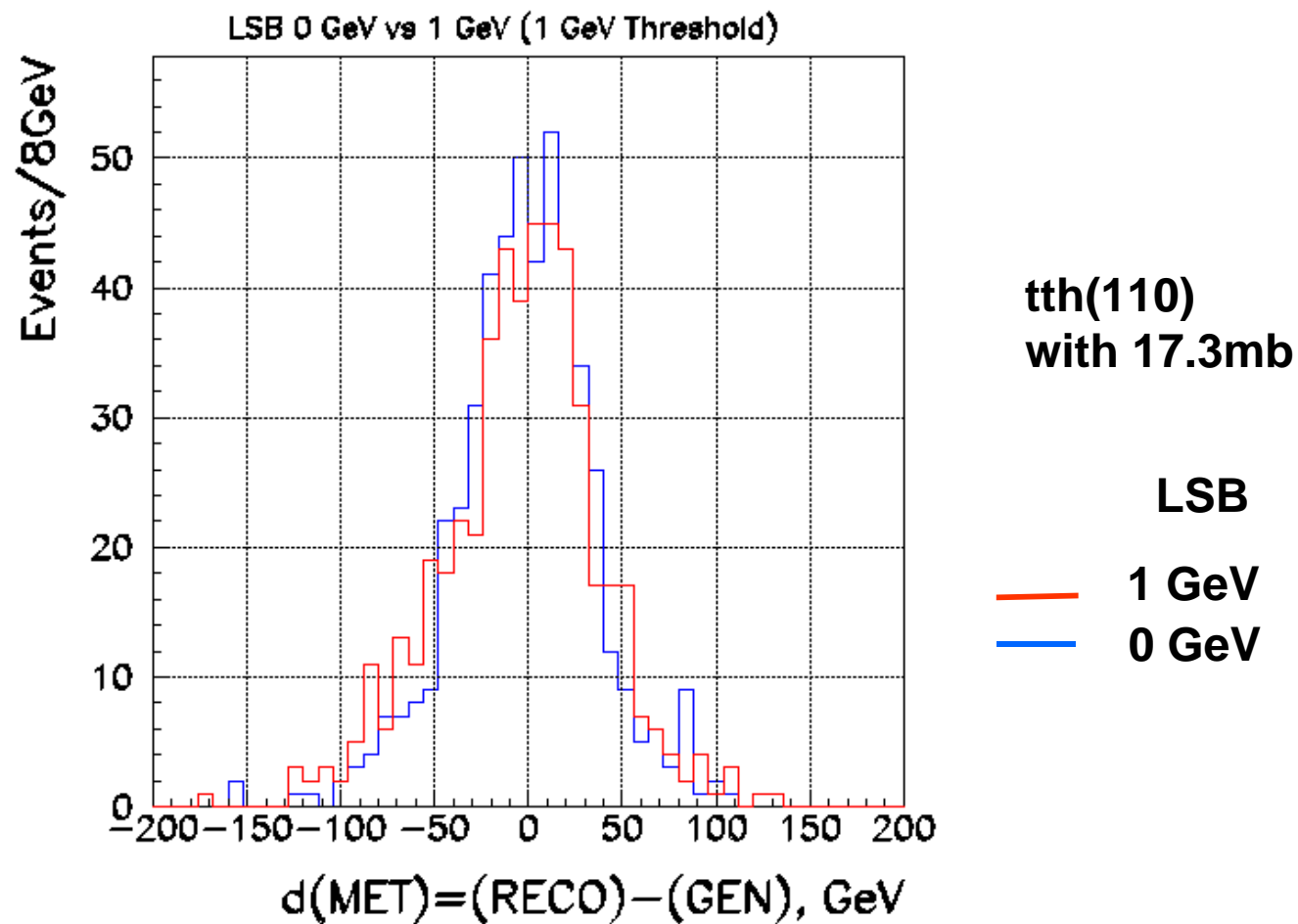
No min-bias

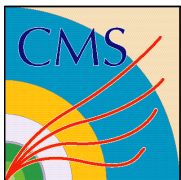


- >> Not much pile-up effect with this resolution!
- >> Resolution gets worse as threshold increase.



# MET and LSB





# Summary

**We just started studies of MET performance at 10E34. We have checked effects due to:**

- eta coverage and (in-time) pile-up
- tower Et threshold / LSB

**=> Need to check effects due to non-linearity**

- algorithm for MET scale correction

**Is there better way to calculate MET than simply using raw readout channels?**

- We may need various algorithm depending on final states. --- using Jets, tracks, etc. ???

**Suggest us challenging bench mark physics processes for offline and trigger MET!**

**HELP!**